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AMSAT® NA *Newsletter for the Amateur Radio Space Program*

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New OSCAR Proves Popular as New Users Climb Aboard!

With nearly a month's experience on the new AMSAT OSCAR 13, the number of users on all modes is increasing as is their apparent satisfaction. Veterans and newcomers alike are praising the new satellite even as it remains in the engineering phase prior to its official turnover for general operations. The condition of the satellite continues to be excellent and, except for an apparent glitch in the RUDAK packet system, optimism prevails.

Modes B and J have been widely applauded for their performance. Their sensitivity seems to be excellent. Although there seem to be few times when the officially recommended uplink power levels suffice, this clearly is attributable to transponder loading and the realization of a typical power escalation scenario.

Higher than the officially recommended uplink power levels are apparently being used by most Mode B and J users. There is thought to be a power escalation cycle that is initiated or accelerated by a few stations who have wholly inadequate receive systems. All users MUST be aware a preamp is essential for all AO-13 modes. Operating without one is a prescription for failure. Operating WITH a good preamp (preferably at the antenna) can convert all the modes (especially L) from a strain to a plain joy.

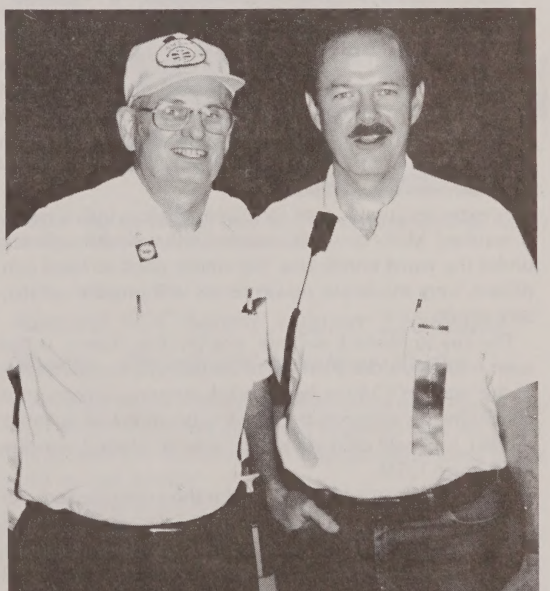
Perhaps the biggest turnaround in user opinion has occurred in the Mode L domain. When first turned on July 24, Mode L was thoroughly panned by U.S. users. Based on what they saw, U.S. users were wondering what European Mode L users where cheering about. It was subsequently learned European Mode L users enjoyed a very strong uplink advantage in the first few days of its operation as a consequence of the squint angle of the satellite; the offset angle between the Mode L uplink antenna and the uplinking station. Analysis now shows a squint angle greater than 10 or 15 degrees to be anathema for good Mode L QSOs.

Another confusing element, which strongly abetted the gap between U.S. and European reports on Mode L performance, was the discrepancy between previously published Mode L frequencies and the ACTUAL Mode L frequencies. For reasons not yet clear, the frequencies previously published by AMSAT-DL and re-iterated by AMSAT-NA and in various U.S. publications have proven erroneous. (The Mode B and J frequency discrepancies are inconsequential; Mode L frequency disparity is substantial. (See related story)

The combination of amplitude and frequency discrepancies led many U.S. satellite users to conclude Mode L had actually failed entirely. Few could even find their downlink at all using all the power they had available to them.

Fortunately, the big swing in opinion came like a whipsaw in early August as Mode L showed off its best to the West. Favorable squint angles came to the U.S. and Mode L users there have changed their views entirely; have been showing up in droves on the new mode.

And, as may be characteristic of U.S. amateurs, they vote with their pocketbooks. When they like something, they support it with equipment purchases. Equipment dealers report an unprecedented run on 24 cm equipment; a sound



AMSAT veterans Tom Walker, W4EWB, (left) and Al Zoller, W6OTE at the Atlanta Convention, July 9.

vote of confidence in Mode L if there ever was one!

With the excellent conditions, analysts too have had a good chance to measure the actual Mode L performance. The results show what to expect under ideal conditions and what to expect otherwise. The resulting numbers suggest AO-13 Mode L is now working better than AO-10 Mode L ever was expected to! (See related story).

On a slightly less positive note, AMSAT-DL workers report there is a problem with RUDAK, the packet digipeater developed in Munich. When attempting to bootload from the PROM, the RUDAK CPU runs for a while but then hangs up. The 10 byte loader module will not allow a special program to be loaded into RAM. It is now recalled from the thermal vacuum tests that the PROM (a fusable link type) was then found to be temperature sensitive. AMSAT-DL is evaluating ways of warming the RUDAK module. One scheme being considered calls for energizing the module next to RUDAK, the LIU (Liquid Ignition Unit). This will warm up RUDAK considerably and may solve the problem they say.

In sum, AO-13 continues to provide excellent performance on all its linear transponders. The RUDAK is being investigated for a possible thermal malfunction and Mode S may be activated next month. New and veteran satellite users alike are singing the satellite's praises and apparently thoroughly enjoying the new bird! Equipment dealers are being swamped with 24 cm equipment orders and there seem few remaining open questions on what Mode L is capable of.

Tests Show AO-13 Mode L Has the "Right Stuff"

On-orbit AO-13 Mode L performance tests completed in early August strongly suggest it is working well indeed; better even than its predecessor (AO-10 Mode L) was expected to work by a couple of dB. The tests also have shown the range of conditions experienced by Mode L users and how to choose the best times to work the new mode. The key to success on Mode L is now clearly shown to be closely coupled with the positioning of the satellite's Mode L 24 cm uplink receive antenna.

As expected, under poor conditions copious uplink power is required. Many tens of kilowatts (EiRP) will be insufficient under the worst conditions. But under good to ideal conditions, very moderate power levels will provide satisfactory results.

The key to Mode L success, analysis has shown, is that users must pay close attention to the pointing or squint angle of the satellite's 24 cm helix uplink antenna. Under good conditions, an approximate 2 hour sub-window of optimum Mode L time will exist within the general Mode L window for a given QTH.

About half the total Mode L time is the prime Mode L sub-window where the squint angles are 10 degrees or less. According to Mode L operator John Gayman, WA3WBU, when squint angles get much over 10 degrees, Mode L uplink power requirements skyrocket.

Thus, it's important to determine the timing of that prime sub-window when your QTH will fall within that acceptance cone. AMSAT's QUIKTRAK program computes the positioning of the cone based on the satellite's attitude in Bahn coordinates, its current position on orbit and your QTH. The PA (pointing angle or squint angle) parameter is output by QUIKTRAK.

Under thoroughly ideal conditions, it now appears a Mode L uplink of 29 dBW (about 800 watts) EiRP will produce about a 10 dB signal-to-noise ratio in a 2.4 kHz channel when received on a system with an approximate 50 degree Kelvin system noise temperature at or near to apogee. (Figure of Merit = -2 dB/K). A 50 degree K, 435 MHz receive system might consist of a 0.6 dB noise figure preamp behind a 15 dBic RHCP antenna and a standard, modern SSB UHF receiver. (CW signal performance is proportionately better).

However, under most practical operating conditions, more uplink power will certainly be required on Mode L. Factors increasing Mode L uplink power requirements include polarization losses (3 dB penalty for running linear polarization instead of Right Hand Circular Polarization); squint angle (penalties mount very fast beyond squint angle of 10 degrees); increased path losses; increased absorption at low elevations angles; heavy transponder loading; local impediments (trees; houses), etc.

Based on these preliminary estimates, it now appears 33 dBW (2 kW) EiRP is the lowest PRACTICAL level Mode L SSB users should expect to be regularly successful with. For higher reliability, that is for your ability to work well when combining penalty factors as described previously, another 5 dB or more should be available. Based on these tests then, 38 dBW (6.3 kW) EiRP can be expected to produce good SSB results under most (but definitely NOT all) operating conditions. Obviously, if one wants to work under the most adverse conditions with strong, compound penalty factors, much more power will be needed.

The 38 dBW level seems, however, to be a reasonable compromise between performance, reliability, cost and physical structure. For example, 30 watts applied to the feed of a pair of 20 dBi loop yagis will produce about 37.3 dBW 5.4 kW) EiRP including losses; sufficient for good SSB QSOs under most conditions and excellent for CW under most conditions.

Comparing AO-13 Mode L and AO-10 Mode L, it now appears the actual measured performance of AO-13 Mode L exceeds the expected performance of AO-10 Mode L by 1 to 2 dB. (Of course AO-10 Mode L never actually achieved its potential performance by a factor of at least 10 dB). By contrast, AO-13 Mode L is coming close to its corrected specs.

New AO-13 Ops Sked Issued August 6

After we went to press with *ASR* #180, a new AO-13 Operating Schedule was issued. Schedules may continue to change in the next few weeks as engineers complete their testing and evaluation programs. To be sure of obtaining the latest schedule information, listen to your local nets or watch for updates in the satellite telemetry.

AMSAT OSCAR 13 continues under engineering jurisdiction and has not yet been officially released for full operations. Spacecraft controllers and engineers met in Marburg, West Germany the first week in August to evaluate spacecraft systems performance to date and to plan general

operations for the near-term and mid-term future. They have agreed on the following revised schedule said to be effective until September 21 but subject to change for continued testing.

Revised Operating Schedule: V3.0 6Aug88

Mode	From (Inclus)	Thru (Inclus)	Remarks	Duration MA Minutes
Off	MA 241	MA 002	Solar eclipse window	18 48.3
Mode B	MA 003	MA 099		97 260.2
Mode L	MA 100	MA 180	Mode JL optional	81 217.3
Mode B	MA 181	MA 220		40 107.3
Mode B	MA 221	MA 240	With omni antennas	20 53.6
Mode S			Commence September(?)	
RUDAK			Testing; ops pending	

The current attitude throughout August will remain about BLON = 180, BLAT = 0.

Surrey Colloquium Well-Received

(Story by UoSAT Staff)

Over 160 persons from 19 countries attended the 3rd AMSAT-UK/UoSAT Space Colloquium held at the University of Surrey last weekend (29-31 July). International speakers presented 20 papers on diverse topics, covering:

- Geostationary AMSAT Phase 4 spacecraft designs
- AMSAT Phase 3D spacecraft design
- UoSAT-C, D and E spacecraft technologies
- Amateur Radio using High Altitude Balloons
- AMSAT OSCAR 13 spacecraft orbital commissioning and operations
- UoSAT-1 & 2 spacecraft orbital operations
- The Chinese Space Program
- Digital signal processing techniques for amateur satellite communications
- Packet Radio Satellites
- Soviet/Canadian Transpolar SKITREK
- Future Soviet amateur radio satellites

Among the many radio amateurs who attended were Jan King (W3GEY), Karl Meinzer (DJ4ZC) and Leo Labutin (UA3CR). Leo was particularly welcome and read a paper describing the SKITREK project and spoke on future Soviet satellite plans.

The Colloquium was preceded by a one-day Satellite Technical Workshop devoted to detailed discussions of advanced amateur satellite techniques and a one-day coordination meeting sponsored by the Radio Society of Great Britain focusing on funding, frequency allocation and educational matters.

Colloquium Proceedings, comprising 16 of the papers presented, were sold out. However, additional copies will be available shortly from AMSAT-UK. The sponsors send their thanks to all who visited UoS last week and who made the Colloquium such a success!

UO-11 Doing In-Orbit Particle/Wave Data Collection

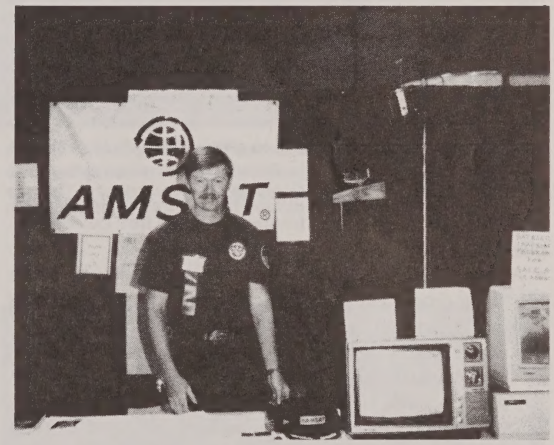
(Story by UoSAT Staff)

Research data may forecast trans-Atlantic VHF openings.

During July a number of particle/wave surveys have been carried out on UoSAT OSCAR 11. Specifically, these surveys have been conducted using the Multi-Channel Electron Spectrometer. The spectrometer detects electrons at eight nominal energy levels: 30, 300, 800, 1600, 3200, 8100 and 13000 electron Volts (eV). Using control blocks, it is possible to initiate a survey at any point in the orbit. Each survey, which occupies 96k of memory, lasts for about 12 minutes.

The surveys are being carried out to assist the Radio Society of Great Britain Propagation Studies Committee in analyzing the propagation of 50 MHz signals across the Atlantic. It is hoped that UO-11 will be able to detect precipitating electrons that may result in the enhanced propagation. The surveys are being carried out as the spacecraft passes over the North Atlantic at around 00:00 UTC.

Results of these surveys will be published in the usual places according to the University of Surrey.



AMSAT Area Coordinator Dave Miracle, KA4UFM, staffs the AMSAT booth in Atlanta, July 9. (W4BIW photo)

Absurd FCC Move Against 220 Band Shakes, Befuddles Amateur Radio

Amateur Radio was badly shaken when on August 4, the FCC adopted a report and order in general docket 87-14, the proposal to reallocate the 220-222 MHz band to the land mobile service.

According to the ARRL, in balancing the impact on existing users, emergency communications, and future amateur growth against land mobile requirements, the Commissioners concluded that the reallocation was in the public interest despite overwhelming opposition.

Wishing to reassure amateurs of its strong support for the service, the FCC emphasized that the remaining 3 MHz of the band, 222-225 MHz, would be available to amateurs

on an exclusive basis, thus removing the cloud that has hung over the status of the band for many years. The effective date of the reallocation will be announced later.

ARRL says it continues to oppose the reallocation, and will pursue all available means to reverse the commission action.

AMSAT emphasized other bands of even greater import to it are similarly vulnerable and urged support of its landmark Phase 4 Geosynchronous Satellite Program to deflect further frequency grabs especially at 1.3 GHz and up.

Short Bursts

• The annual meeting of the Central States VHF Society took place in Lincoln Nebraska the weekend of July 22-24. According to Bill Tynan, W3XO, quite a number of AMSAT Members were on hand. They included AMSAT Regional Coordinator Keith Pugh, W5IU, who accepted a donation from CSVHFS on behalf of AMSAT. Keith got the "customary" $400 check plus a $200 "Well Done" bonus for the success with AO-13. AMSAT expresses its thanks to the CSVHFS for these kindnesses.

• The current AMSAT fund raising drive initiated by a letter to all domestic AMSAT members is quickly becoming the most successful in AMSAT history only 3 weeks after it was kicked off. Those who donated $20 or more to the fund will be receiving their free, handsome all-OSCARs frequency guide in the mail soon. The frequency guides, including the latest AO-13 frequency updates, are now in production and will be mailed to all qualified donors before the end of August. There is still time for those who haven't already done so to mail in their donations in the envelope supplied and receive their frequency guide free before supplies are exhausted.

• AO-13 "First Day Club" logs, certificates and QSL cards are being processed and should be mailed to all qualifiers by mid-September.

• AMSAT OSCAR 10 is out of service until further notice. Its the hibernation season for this veteran bird.

• JARL says it will soon begin work on another flight model of JAS-1 with an eye towards launching a second OSCAR after a long hiatus since the launch of JAS-1 (FO-12). Efforts with JAS-1B will focus on improving the satellite's tight power budget and antenna directivity in order to obtain a flatter pattern for better performance.

• Here is the FO-12 operating schedule.

Mode	From	(UTC)
DI	Aug 19	0712
JD	20	0415
DI	21	0523
JD	25	0348
DI	26	0457
JD	27	0606
D	28	0511
JA	30	0120
D	Aug 31	0228

JD = Digital mode
JA = Analog mode
D = All systems off
DI = Systems off except CPU and memory

The transponders will be off at other times. The actual operating schedule may change due to unexpected situations such as variations in available power. Mode JA Beacon: 435.795 MHz. Mode JD Beacon: 435.910 MHz.

Revised AO-13 Frequencies

For reasons not now clear, the frequencies of the Mode L transponder are significantly different than those AMSAT-NA previously published and which appeared in *QST*. The tables previously published were based on similar tables published in the AMSAT-DL Journal and supplied separately to AMSAT-NA. The differences in the Mode B and Mode J frequencies are inconsequential and amount to only a couple of kilohertz; less than Doppler shift in some cases.

But the magnitude of the Mode L discrepancy (21 kHz) is a puzzle. The discrepancy probably abetted some of the initial confusion experienced by would-be Mode L users in the days immediately after it was first turned on. Since their downlinks were much weaker than expected (because of poor squint angles) and the marginal downlinks were well outside of the range of frequencies one might think to sweep looking for one's downlink, many initially despaired of finding themselves. Some gave up concluding Mode L was a failure. AMSAT-NA regrets any inconvenience the frequency discrepancies may have caused.

Here are the frequencies for the three linear modes B, J and L. These data are the result of actual on-orbit measurements fully corrected for Doppler shift. The values are believed accurate to 1 kHz.

Mode	Sum of Up and Downlink Frequencies	Uplink Mid-Band Frequency	Downlink Mod-Band Frequency
B	581.398 MHz	435.508 MHz	145.890 MHz
J	580.413 MHz	144.448 MHz	435.965 MHz
L	1705.356 MHz	1269.496 MHz	435.860 MHz

A correlation between J and L uplinks and the JL downlink has now been confirmed. The JL downlink sub-band center is 435.965 MHz. The corresponding L uplink is 1269.391 MHz. The corresponding J uplink is 144.448 MHz. Thus, stations transmitting on 1269.391 and 144.448 MHz should appear on the same downlink frequency in the absence of Doppler shift.

The Mode B uplink frequency is 3 kHz higher than previously announced.
The Mode J uplink frequency is 2 kHz lower than previously announced.
The Mode L uplink frequency is 21 kHz higher than previously announced.

When making frequency measurements, careful attention must be paid to Doppler shift. All beacon frequencies appear to be very close to the previously announced values; to within a kilohertz. The AMSAT-NA All-OSCAR Frequency guides have gone into production accurately the measured frequency values.

AO-13 Ground Track

As the argument of perigee of AO-13 changes, so does the latitude of apogee. In Figure 1, we see the ground track (in white) where apogee occurs at about 7° North. Five years from now, in February, 1993, apogee will reach its maximum northerly point, 57.6°, equal to the orbital inclination, as seen in Figure 2. Note sharp changes in shape of ground track. By 5 years later, February, 1998, (Figure 3) apogee has returned to the equator but the ground track is the mirror image of the earlier case (Figure 1). Finally, 5 years later, February, 2003, the apogee has reached its maximum southerly extent (Figure 4). (All plots by GRAFTRAK by Silicon Solutions, Houston)

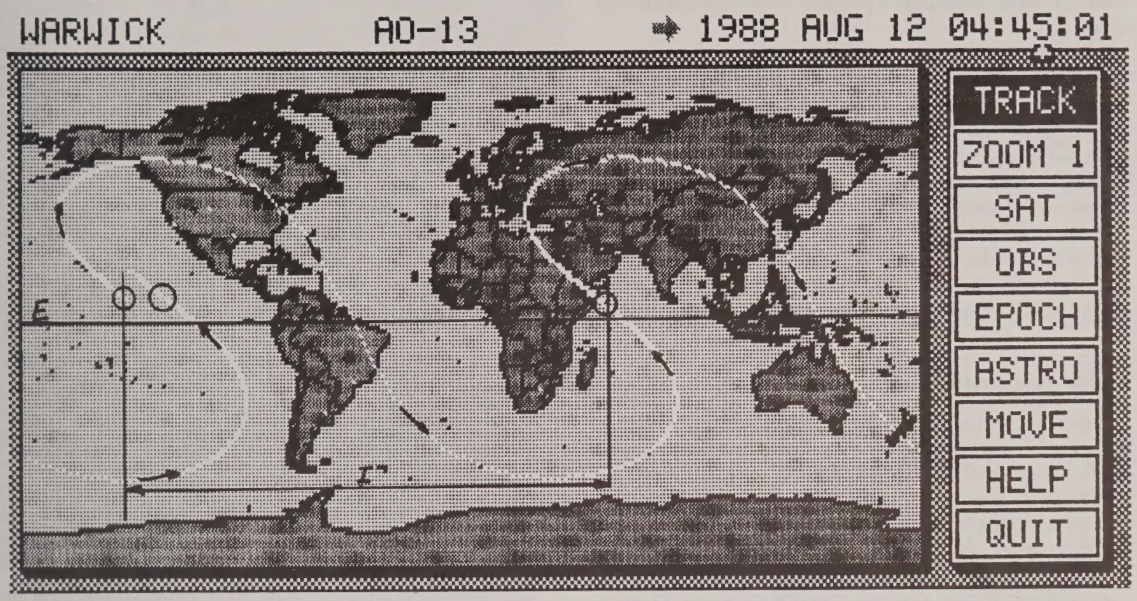


Figure 1—AO-13 ground track as it was in mid-August, 1988. The circles denote where apogees occurred (about 7.5°N). Note longitude increment "I" between successive apogees is 187.81° East per orbit. Ground track is made up of white dots spaced one minute apart.

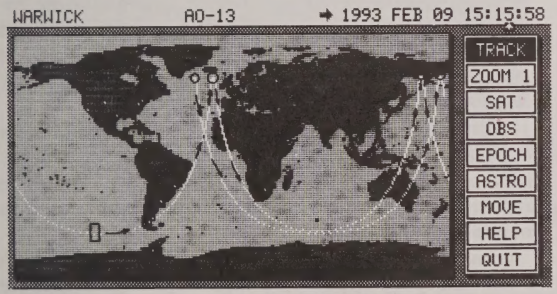


Figure 2—AO-13 ground track five years hence. Circles denote apogees. Four are shown. The rectangle contains perigee.

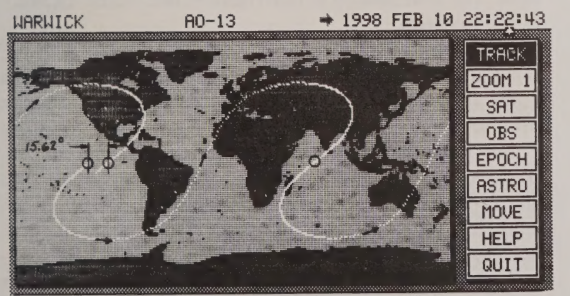


Figure 3—AO-13 ground track 10 years hence. Circles denote apogees. The easterly progression of the ground track remains 187.81° per orbit or 15.62° East per 2 orbits as the plot shows.

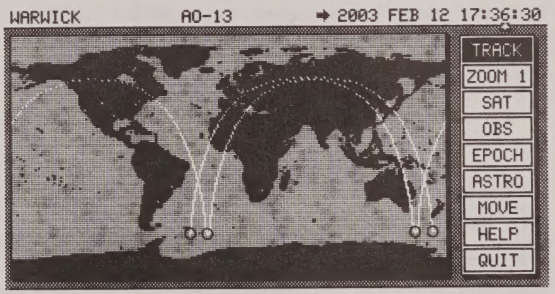


Figure 4—By February, 2003, apogees (shown in the circles) will occur at 57.6°S.

DCE Linking Extended Further

(Story by UoSAT Staff)

The UO-11 DCE (Digital Communications Experiment) packet radio gateway network continues to grow. ZL1AOX, VK5AGR, GB3UP and ZS6SAT are passing messages for large packet radio user networks in New Zealand, Australia, the UK and South Africa. A new station, ZL5BA, is located on Ross Island in the Antarctic. The operator there (SoJo)

is working at a Greenpeace scientific base. He will use his DCE station for recreation and to send health & welfare messages home for the others at his base. ZL5BA was activated on 29 July and is providing an interesting insight into the coverage received by polar stations from a polar orbiting satellite. He sees UO-11 on almost every pass although some times of day provide higher elevations than others.

Surrey plans to commission a USA gateway soon. The station is N6IIU in the San Francisco area. This station is located in a Red Cross headquarters which already houses an emergency communications station and a packet BBS. Discussions are also under way with an East Coast USA amateur. Meanwhile, a gateway in West Germany is also almost ready to go. DB2OS, one of the AO-13 control operators, will bring DCE access to the well-developed European packet radio network. When the USA and Europe are on line, the DCE will be able to link together all of the major amateur radio packet networks worldwide.

"Do Svidaniya" RS-5 and 7

Recently, Leonid Labutin of Moscow, a prime mover in the Soviet Radio Sputnik (RS) program, said that on July 15 the first western amateur visited the USSR RS command station RS3A in Moscow. Danny Kohn, SMØNBJ, of AMSAT-SM, visited UA3CR during his recent stay in Moscow. Danny interviewed the chief operator there, Leo Maxakov, RA3AT, made tape recordings and took pictures.

According to Nico Janssen, PAØDLO, upon Danny's return to Stockholm, he promised to make an extensive report on his visit to RS3A. One of the interesting things he has already told the European AMSAT Net (on July 23) was, that according to the operators at RS3A, the old RS satellites, RS-5 and RS-7, are definitely out of operation now. RS3A has gradually lost control over these last two active RS satellites of the RS-3 to RS-8 series. They are convinced that the batteries in RS-5 and RS-7 are dead so no new activities can be expected from these satellites. RS-3 through RS-8 were launched together on December 17, 1981.

AMSAT Pioneering New Class of "Microsats"

A consortium of Amateur Radio groups and a Utah college have teamed to construct and launch a new class of ultra-compact "microsatellites". They are so small they can be launched on virtually any launcher. They are inexpensive enough that they may change the face of Amateur Radio by providing many more satellites with a variety of functions and modalities for Amateurs.

Three AMSAT organizations, AMSAT-NA, AMSAT-LU and BRAMSAT (Brazil AMSAT) have teamed with the Center For Aerospace Technology (CAST) at Weber State College, Ogden, Utah to produce four satellites. TAPR is providing initial financial support and ARRL is assisting with design and construction.

Each satellite consists of a bus of common design which carries a mission-specific payload. AMSAT-NA and AMSAT-LU payloads are packet radio transponders (PACSATs). BRAMSAT's payload is a voice synthesizer and the CAST payload is an earth-looking, low-resolution CCD camera.

The most unique characteristic of each satellite is its volume and mass. Only 23 cm (9 inches) on a side, each cubical spacecraft weighs less than 10 kg (22 lbs). The small mass and volume make it feasible to launch these spacecraft inexpensively. And microsats can fit where larger ones cannot so many more near-term launch opportunities are available.

Microsats pioneer a new class of payload analogous to NASA's Shuttle Getaway Special cannister (GAS can) only smaller. AMSAT has pioneered small satellites for nearly 20 years with roles in OSCARs 5 though 13.

A PACSAT is a packet radio store & forward communications satellite which can blanket every inch of the earth up to eight times per day. Two PACSATs will be built: One each for AMSAT-NA and AMSAT Argentina.

AMSAT Argentina had undertaken a satellite project of its own beginning in early 1988 but decided to collaborate with AMSAT-NA on the PACSAT project instead.

"We thought it would be most efficient to join with our colleagues from AMSAT-NA in the development of our satellite project," said AMSAT Argentina President Carlos Huertas, LU4ENQ. "We have found a way to incorporate many of our own ideas in the basic PACSAT design," Huertas said.

Arturo Carou, LU1AHC, says "The satellite will be jointly constructed but financed by Argentine sources and licensed in Argentina. When placed in operation, LU-SAT will be commanded from Argentina but will be available for non-profit use by Radio Amateurs worldwide."

BRAMSAT's Project DOVE (Digital Orbiting Voice Encoder) aims to "Be the first satellite specifically designed to transmit spoken messages that implicitly promote peace between the nations" says Brazil AMSAT President Dr. Junior DeCastro, PY2BJO.

Project DOVE's primary function is to make direct access to satellite communication available to the "average man". It will produce signals which can be heard on inexpensive VHF scanner type radios — the type commonly used to monitor police bands.

Its implicit message of peaceful use of space will flow from an explicit space education mission. "It will not become a propaganda machine for anyone," PY2BJO says. "BRAMSAT will have the voice synthesizer programmed for various languages to interest students in developing engineering skills...the kind needed to build devices like Project DOVE," DeCastro adds.

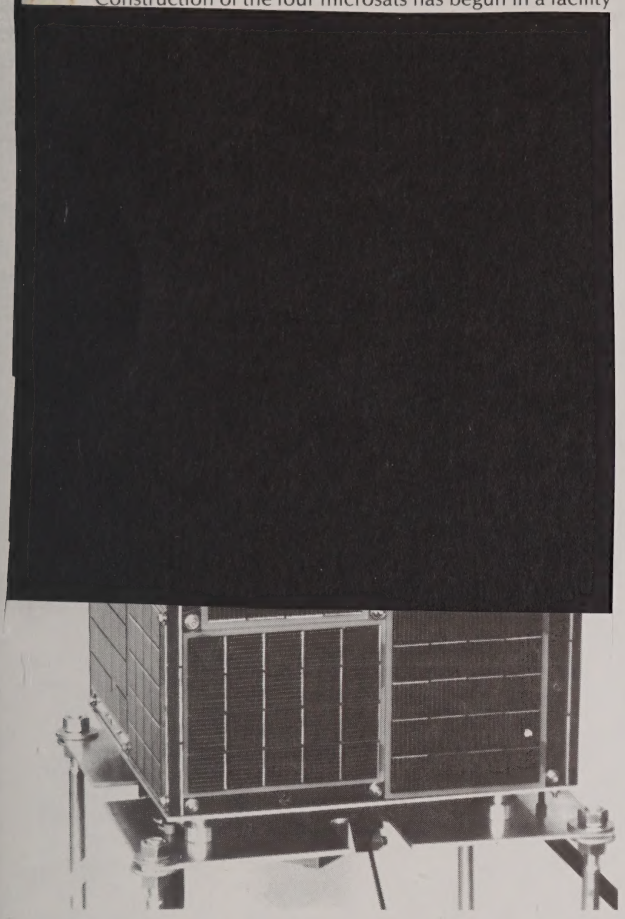
According to the mission plan revealed by PY2BJO, DOVE will transmit various telemetry parameters measured by its many sensors to provide a rich source of data on satellite in-orbit behavior. These data will be easily accessed by the "common man" because they will be transmitted in synthesized speech requiring no special receiving equipment; simply a VHF radio, a pad of paper and a pencil.

PY2BJO emphasized "This mission has immense educational value for anyone equipped with a simple VHF scanner. It's a window to space for students and scientists in many areas of scientific research seeking easy, reliable access to such data."

"The success of UoSAT OSCAR 11's Digitalker relaying

SKITREK position data to perhaps 250,000 students and teachers equipped only with simple VHF radios has underscored our conviction there is great social value in Project DOVE," said Dr. DeCastro, PY2BJO.

Construction of the four microsats has begun in a facility



Closeup of AMSAT-NA's new microsat bus shows details of solar cell modules called "clips". The standard microsat bus is 23 cm (9") on a side and weighs 10 Kg (22 lbs.). Smaller even than AO-6, microsat will carry custom, mission-specific modules providing unusually high levels of functionality. (AMSAT-NA photo by Dick Jansson)

Arianespace Launch Manifest Includes New AMSAT Microsat Cluster

Arianespace, the marketing and management arm of the European Space Agency, has announced its new launch manifest which includes a launch on which AMSAT will fly 4 satellites in its new class of microsats. The University of Surrey has likewise booked a launch for two of its UoSATs on the same mission. That will make a total of 6 of the new class of satellites that will be launched together with the SPOT-II primary payload next June.

Launch	Launch Date	Launch Vehicle	Payload Satellites
V-25	09/88	Ariane 3	G-Star III/Geostar R02 + SBS-5
V-26	10/88	Ariane 2	TDF-1
V-27	11/88	Ariane 4	Astra-1 + Skynet 4B
V-28	12/88	Ariane 2	Intelsat V F15
V-29	01/89	Ariane 4	JC-Sat 1 + MOP-1
V-30	02/89	Ariane 2	Tele-X
V-31	03/89	Ariane 4	Superbird A + DFS-1
V-32	04/89	Ariane 3	Olympus
V-33	05/89	Ariane 4	TV-Sat 2 + Hipparchos
V-34	06/89	Ariane 4	SPOT-2*
V-35	09/89	Ariane 4	Intelsat VI F1
V-36	10/89	Ariane 4	Superbird B + Inmarsat 2 F1
V-37	11/89	Ariane 4	TDF-2 + DFS-2

*AMSAT plans to fly 4 microsats on this mission including projects sponsored by AMSAT-NA, AMSAT-LU, BRAMSAT and the Center for Aerospace Technology (CAST) at Weber State College, Ogden Utah. The AMSAT-NA and AMSAT-LU projects are PACSATs while BRAMSAT's and CAST's projects are aimed at a space education mission. UoSAT D and E are aboard as well.

Flontilla's Fabulous Flying Factoid Factory

by Flontilla Honeysuckle, FY1NFO

Here's a collection of nearly worthless facts about AO-13's orbit that you may never have to recall from memory. These are provided for conversation fillers or in place of the standard "Please QSL via the bureau" cannon fodder. Henceforth, instead of resorting to that old saw, you can simply whip out, "Hey, did you know that in February, 1993, AO-13's apogee latitude will equal its inclination?" Who could argue with a true factoid like that?

1. GENERAL

Apogee:	36,264.507 km	2.84 earth diameters
Perigee:	2,545.826 km	0.2 earth diameters
SMA:		25,783.070 km
Eccentricity:		0.6538919
Inclination:		57.6540 deg
Period (anomalistic):		686.701959 min/orbit
Mean motion:		2.0969796 orbits/day
		765.92 orbits/year
W (dot)		0.049062 deg/day
Orbital increment:		187.81 deg E/orb

2. VELOCITIES

On-orbit velocity at apogee:	1798.7 m/sec
On-orbit velocity at perigee:	8595.5 m/sec
Perigee-to-apogee velocity ratio:	4.78

3. APOGEES

Present latitude of Apogee:	7.2 deg N
Present latitude of perigee:	7.2 deg S
Present rate of change of apogee latitude:	0.02 deg N/orbit
Date of apogee at maximum north (57.6N):	February 1993
Date of apogee return to equator:	February 1998
Date of apogee at maximum south (57.6S):	February 2003
Date of apogee return to equator:	February 2008
Approximate cycle length:	20 years

4. MA CLOCK

MA Clock interval:	2.68249 min/tick
	160.95 sec/tick
MA Clock frequency:	22.36778 ticks/hr

5. EQUATOR CROSSING PATTERN:

EQX repeats to within		Every (on average)
10 deg	17.52 orbits	8.35 days
5 deg	37.11 orbits	17.70 days
1 deg	185.61 orbits	88.51 days
.5 deg	356.39 orbits	169.95 days
.01 deg	1458.38 orbits	695.47 days (1.95 years)

Commentary:

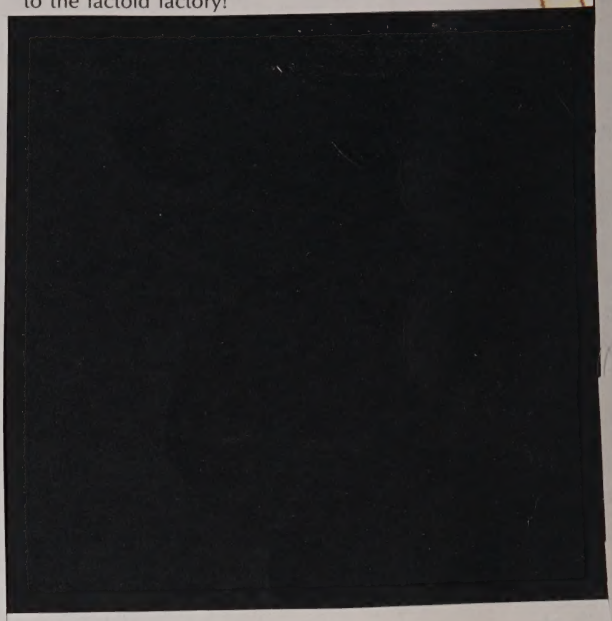
Part 1. This is pretty standard stuff. Anomalistic period is the time interval between successive perigees. (Nodal period, as associated with circular orbits, is the time interval between successive ascending nodes). W (dot) is the rate of change of the argument of perigee. This is tied to the inclination in a complex way. See equation 8.12 in the ARRL's Satellite Experimenter's Handbook, page 8-8. The orbital increment is the longitude increment between successive ascending nodes.

Part 2. A big "So what" on these factoids. I can't imagine how knowing this will improve your enjoyment of AO-13!

Part 3. The rate of change of the latitude of apogee is non-linear. The rate is highest when apogee is close to the equator and lowest at the extreme latitudes and become zero when the latitude of apogee equals the inclination. The curve of the rate of change versus time is a sine (or cosine) curve. Even optimists doubt AO-13 will remain operational when its apogees occur at 57 degrees South in February of the year 2003.

Part 4. Basically another "so what?" But I guess it's handy to recall they're about 161 seconds per tick. Why that might be handy, I haven't got a clue.

Part 5. Now here's some real material. Can you imagine the thrill you will convey when you tell your factoid download target that the orbital pattern of AO-13 repeats every 1.95 years to within a hundredth of a degree of longitude? Then just hope he's not smart enough to point out that the argument of perigee will have changed in that period sufficiently to nullify your visions of groundtracks exactly retracing their paths by a wide margin! Oh well. Back to the factoid factory!



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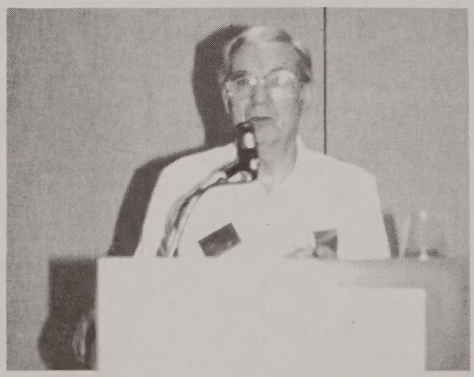

Regional Coordinator Byron Lindsey, W4BIW, presents at the Atlantic Radio Club Convention, July 9.

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